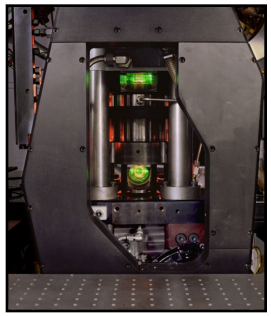
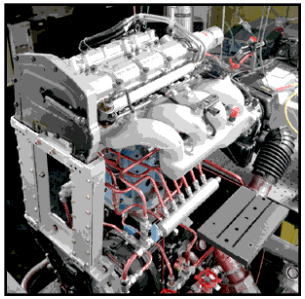
Combustion Research Facility

Customers have access to unparalleled breadth and sophistication of facilities and diagnostics

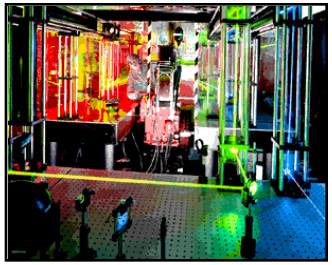
EXHAUST GAS RECIRCULATION



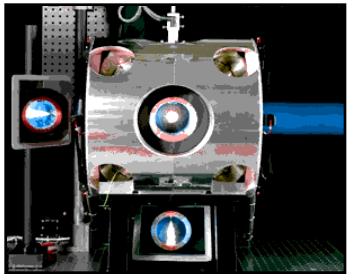
HIGH-SPEED DIRECT INJECTION DIESEL



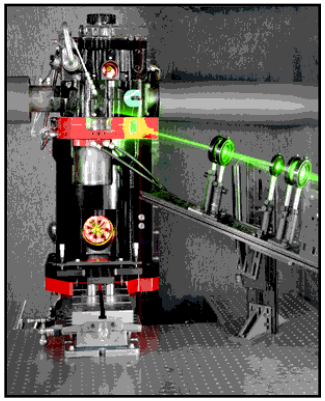
PORT FUEL INJECTION



ALTERNATIVE FUELS

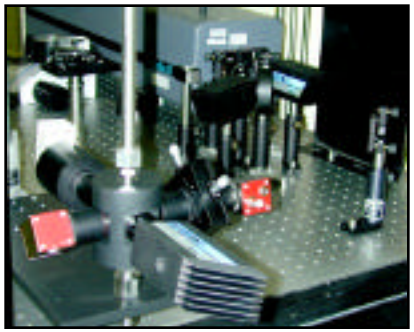


DIESEL SIMULATION FACILITY



HEAVY-DUTY DIESEL ENGINE

GASOLINE DIRECT INJECTION Side Injection



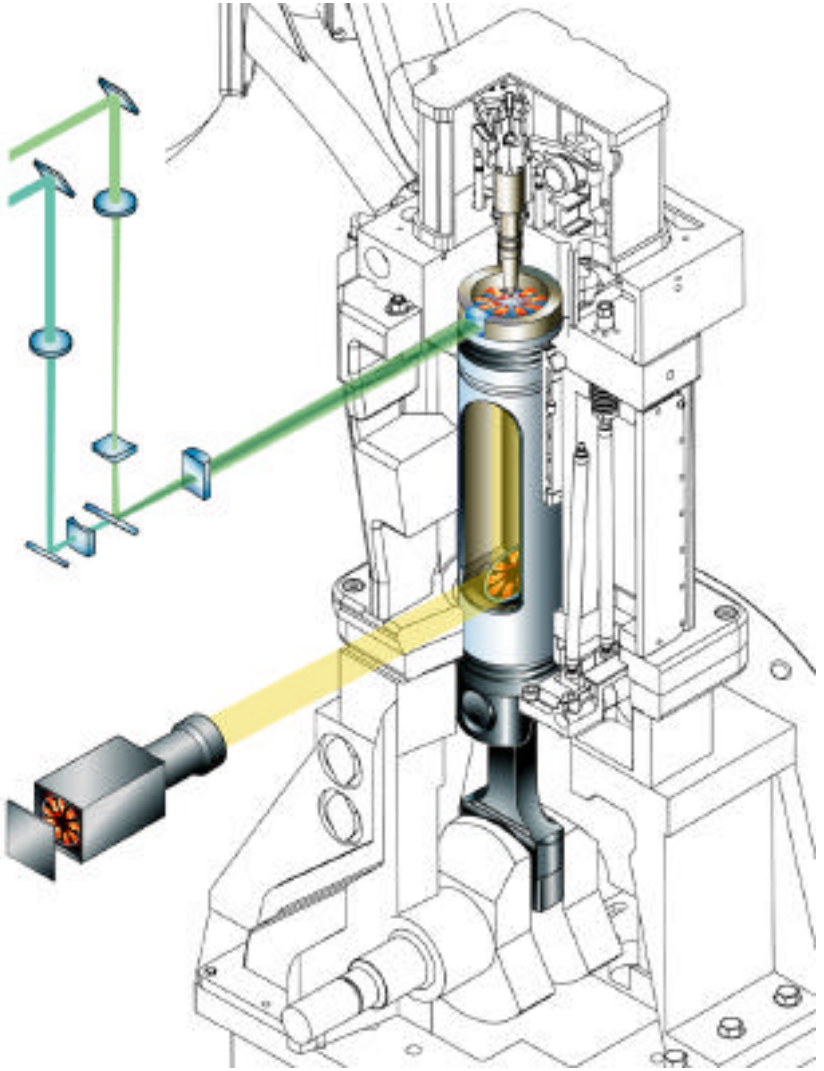
PARTICULATE MATTER DIAGNOSTICS

HYDROGEN LEAN BURN ENGINE PROGRAM

Program Overview

- **CRF's approach is to assemble experimental hardware that mimics a realistic engine geometry while providing optical access.**

- **Optical access is obtained through periscopes in an exhaust valve or through quartz windows in piston crowns, spacer plates and quartz cylinder liners.**



CRF is working in partnership with engine manufacturers to enable more fuel efficient, cleaner burning engines.

GM

Cummins

Ford

Precept

PNGV

DaimlerChrysler

ESX3

USCAR

SHARING TECHNOLOGY FOR A STRONGER AMERICA

DETROIT DIESEL

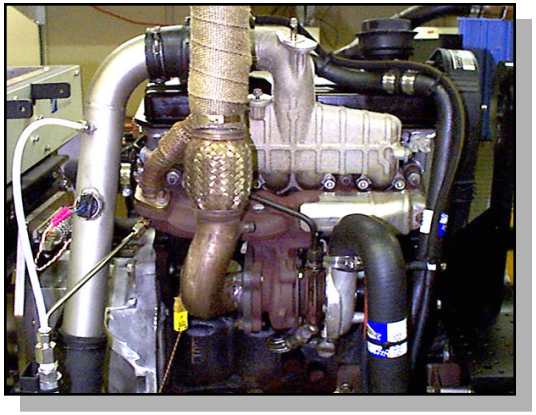
CATERPILLAR

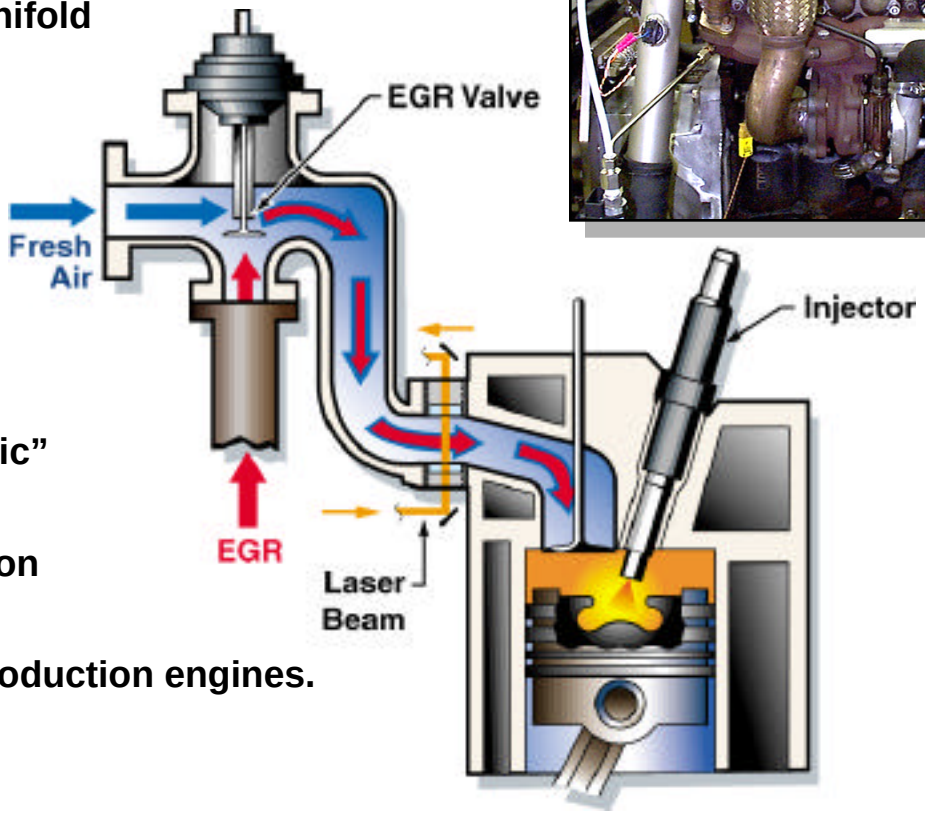
Prodigy

Exhaust Gas Recirculation

Objective:

Develop and apply diagnostics to measure the distribution of EGR in the intake manifold of a high-speed, DI Diesel engine.





Approach:

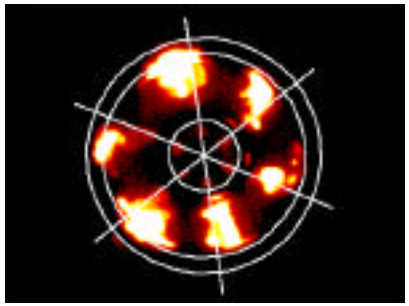
- **Experimental measurements in "generic" production engine.**
- **Focus on engine transients (acceleration and deceleration).**
- **Apply technique to measure EGR in production engines.**

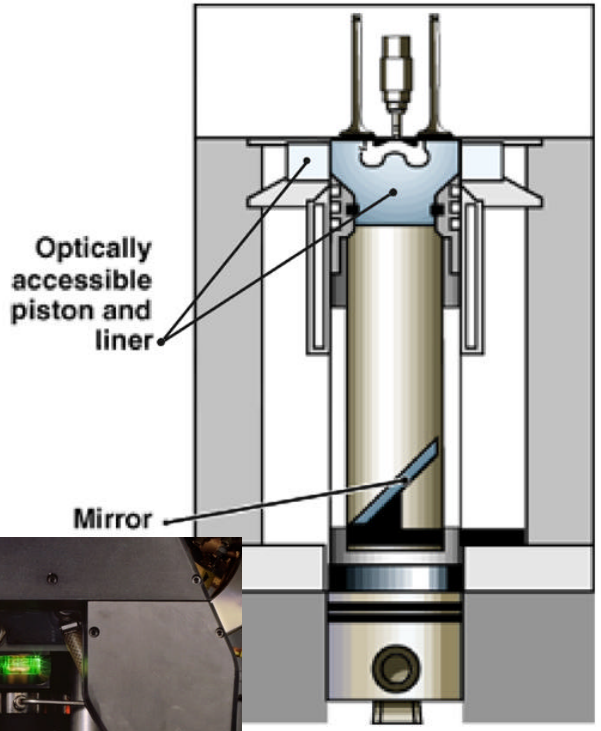
Principal Investigator: Bob Green

High-Speed, Direct-injection Diesel

Objective:

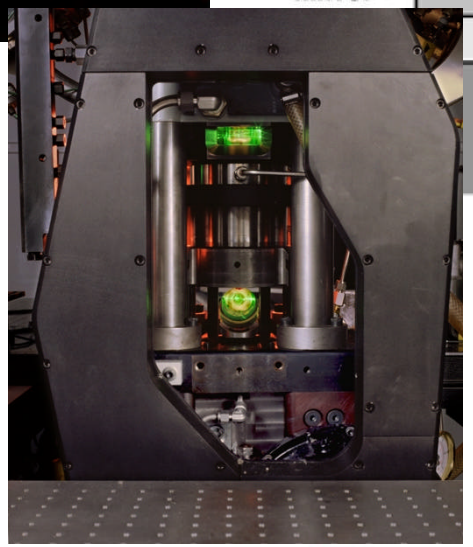
To provide the technological understanding required to enable HSDI diesel engines to meet the efficiency and emissions standards of a PNGV vehicle.





Approach:

- **Understand the physical processes and phenomena important to clean, efficient combustion in swirl-supported combustion systems.**
- **Develop physics-based models of the important combustion processes.**
- **Apply fundamental understanding and developed models to refine and optimize HSDI diesel engines.**

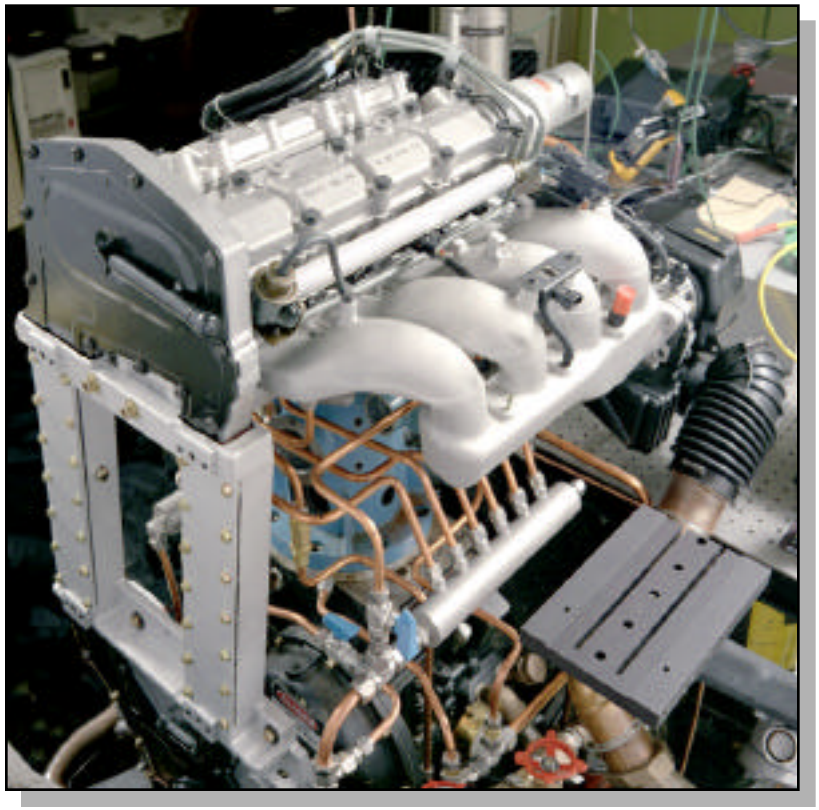


Principal Investigator: Paul Miles

Port Fuel Injection

Objective:

Investigate gasoline additives for improved cold-engine drivability and emissions performance equivalent to or better than gasoline with higher and/or tightly controlled volatility specifications.



Approach:

- **OH* Chemiluminence for burning rate.**
- **Fiber-optic spark plug ports for flame kernal development.**
- **Fast-flame ionization detector (FFID) for UHC.**
- **Pressure measurements for combustion performance**

Principal Investigator: Pete Witze

Alternative Fuels

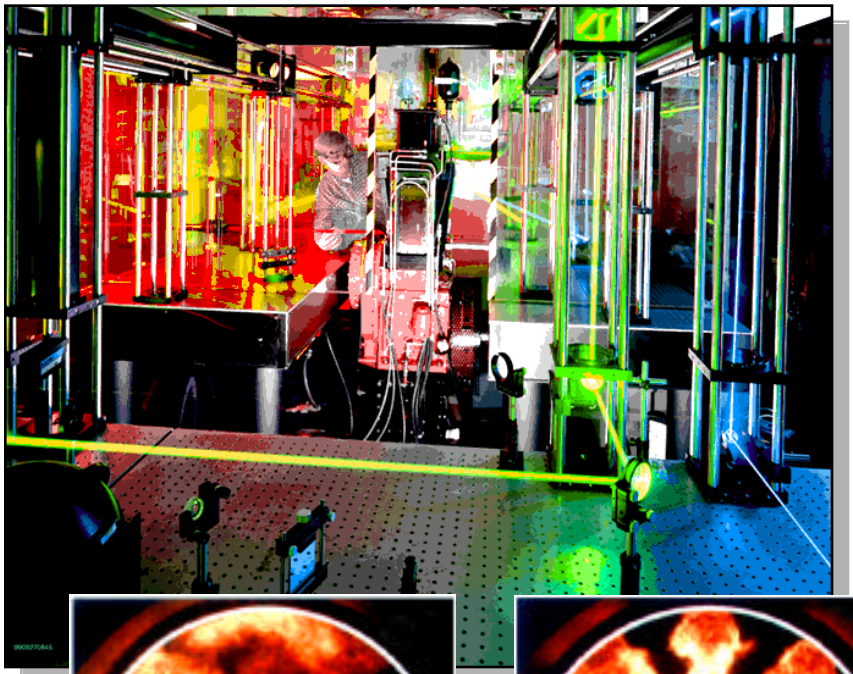
Objective:

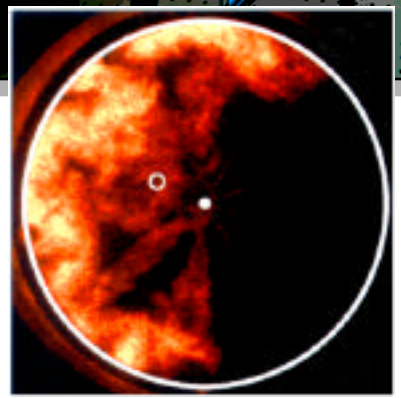
Develop fundamental understanding of alternative fuel combustion processes in heavy-duty CI engines.

Approach:

Apply laser-based imaging diagnostics to state-of-the-art engine hardware with optical access

- **shows pollutant formation – when, where, how much.**
- **shows how changing fuel properties affects mixing and combustion processes.**





M85 (Glow plug on)

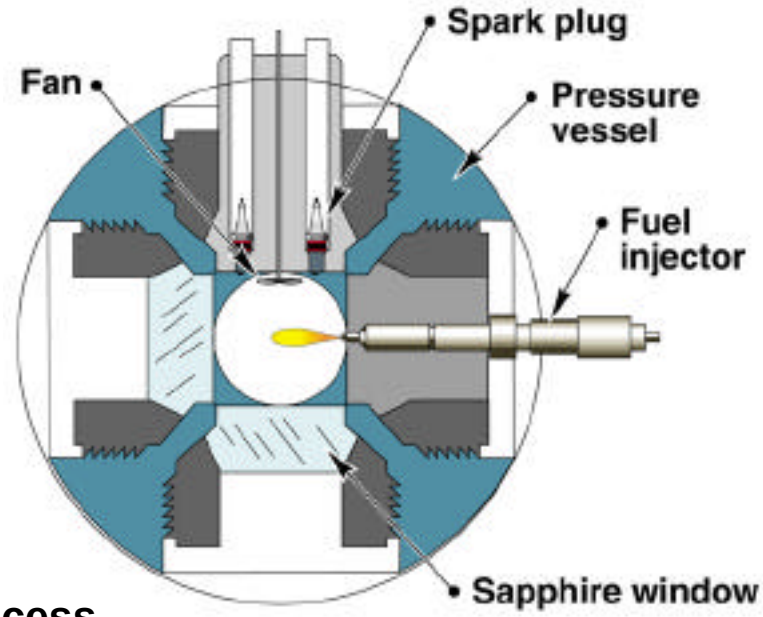
CN45 (Glow plug off)

Principal Investigator: Chuck Mueller

Diesel Simulation Facility

Objective:

Investigate the effects of injector, in-cylinder and fuel parameters on diesel combustion/ emissions processes with emphasis on high power density engine conditions.

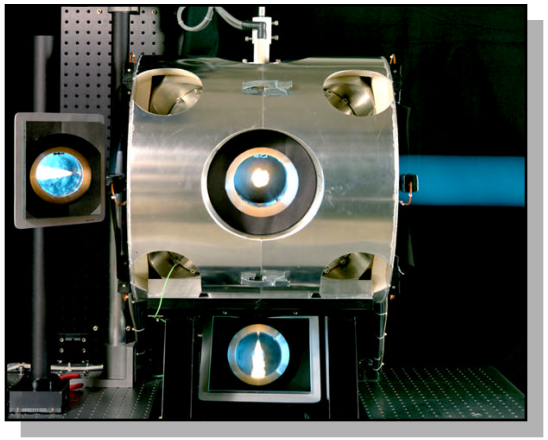


Approach:

- **Utilize unique diesel combustion simulation capabilities that provide complete optical access to a wide range of conditions.**

Pressure	**2-35 MPa**
Density	**4-60 kg/m^3**
Temperature	**600-1400 K**
Composition	**inert - EGR - air - O_2 enriched**

- **Apply advanced diagnostics (Mie scattering, LII, etc.)**
- **Develop physics-based models of diesel spray processes.**



Principal Investigator: Dennis Siebers

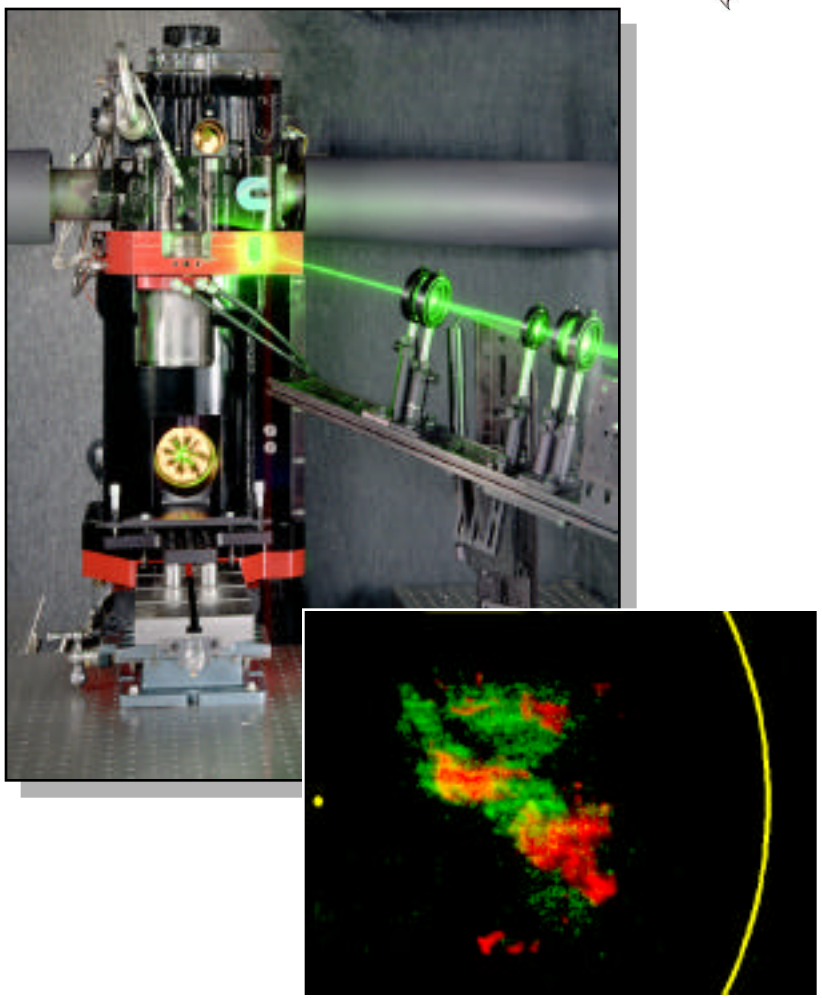
Heavy-Duty Diesel Engine

Objective:

To provide the fundamental understanding needed to help manufacturers reduce emissions (soot & NOx) and improve performance.

Approach:

- **Utilize a optically accessible engine derived from a heavy-duty Cummins truck engine.**
- **Apply multiple planar imaging (LIF, LII, Mie, Rayleigh, etc.) and other diagnostics to the in-cylinder processes.**



Green: OH (LIF) Red: Soot (LII)

Principal Investigator: John Dec

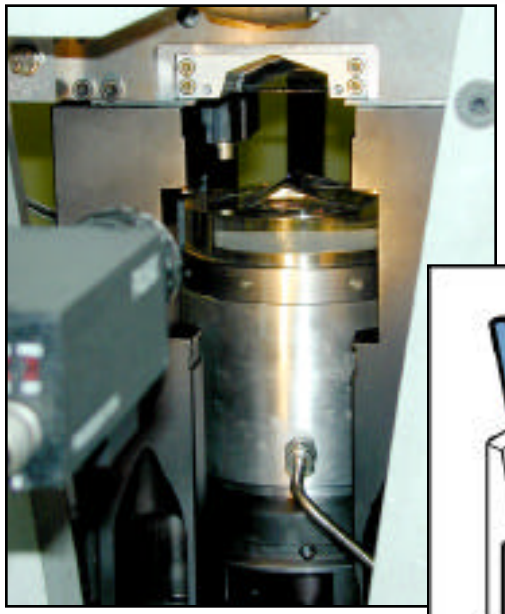
COMBUSTION RESEARCH FACILITY
Engine Combustion Department

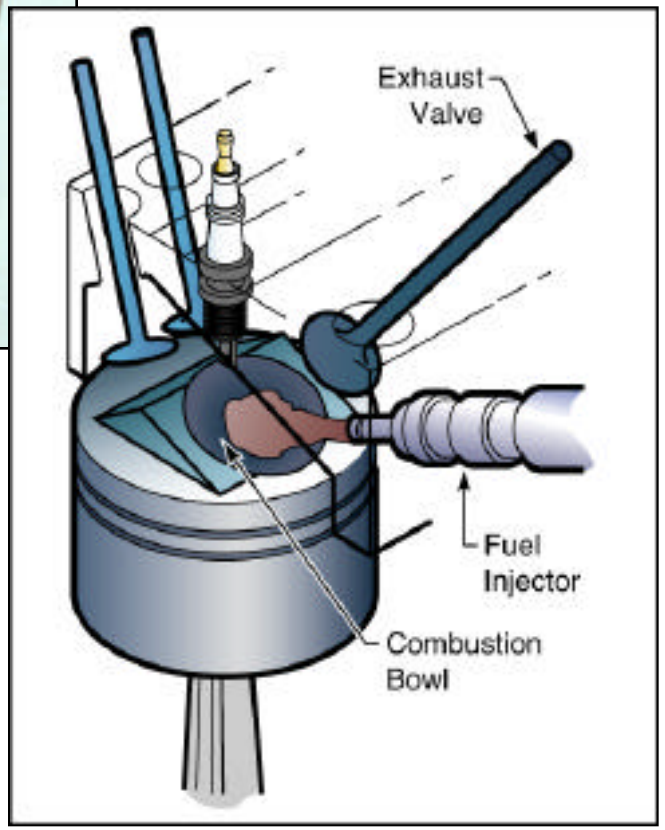
Sandia National Laboratories

Gasoline Direct Injection (side injection)

Objective:

Investigate fuel/air mixing and combustion in a spark ignition, direct injection engine with a side-mounted injector.





Approach:

- **Probe spray and fuel vapor evaluation using laser elastic scattering and laser-induced fluorescence.**
- **Investigate combustion characteristics using flame luminosity (color and total intensity), and laser-induced incandescence.**

Principal Investigator: Greg Fiechtner

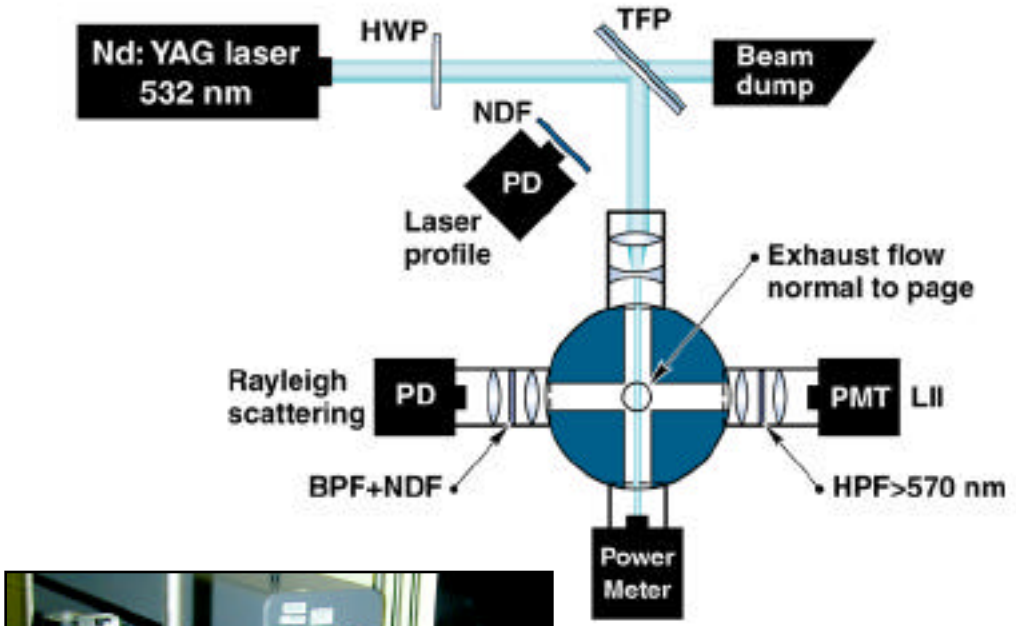
Particulate Matter Diagnostics

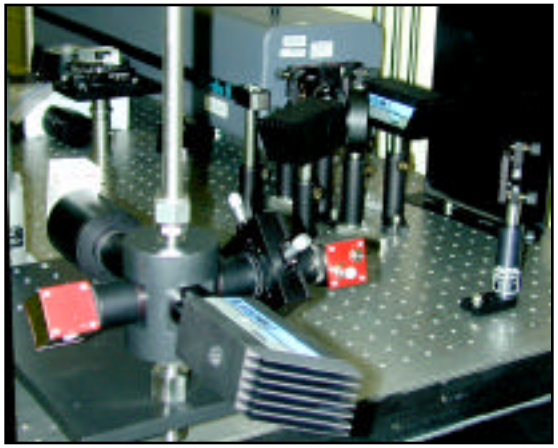
Objective:

Develop new diagnostic tools for the *real-time* measurement of nano-sized particles.

Approach:

- **Laser-induced incandescence (LII)**
- **Laser-induced vaporization/elastic scattering (LIVES)**
- **Multi-angle elastic scattering (Rayleigh-Gans-Debye theory)**
- **Calibration with scanning mobility particle sizer (SMPS)**





Principal Investigator: Pete Witze

Hydrogen Lean Burn Engine Program

Objective:

Development of an internal combustion engine fueled on hydrogen for stationary and transportation applications. Optimize engine operation for maximum efficiency with near zero emissions.

Approach:

- **Maximize indicated thermodynamic efficiency by using unique combustion characteristics of hydrogen air flames.**